

**I claim:**

1. A method for generating a secondary isotope from a precursor isotope comprising:

introducing a charge into a generator system, the charge including a volume of a precursor compound that includes the precursor isotope, the generator system having operating conditions selected to maintain the precursor compound as a gas;

maintaining the charge within the generator system for a period sufficient for a quantity of the precursor compound to decay and produce a target quantity of a secondary compound that includes the secondary isotope;

collecting the secondary compound as a solid on a collection surface within the generator system;

trapping a volume of the precursor compound in a cold trap arranged within the generator system, the cold trap being remote and separable from the collection surface and having operating conditions under which the precursor compound is a liquid or a solid;

eluting the collection surface with an eluant solution to remove a major portion of the secondary compound from the collection surface and form an eluate containing substantially all of the secondary compound;

removing the eluate from the generator system.

2. A method for generating a secondary isotope from a precursor isotope according to claim 1, wherein:

the charge further includes a volume of an oxygen scavenger.

3. A method for generating a secondary isotope from a precursor isotope according to claim 2, wherein:

the charge further includes a volume of an inert diluent.

4. A method for generating a secondary isotope from a precursor isotope according to claim 3, wherein:

the precursor compound is germane that is radiolabeled with  $^{68}\text{Ge}$ ;

the oxygen scavenger is silane;

the inert diluent includes a compound selected from helium, neon, argon, krypton and xenon; and

the eluant is an aqueous solution of hydrochloric acid.

5. A method for generating a secondary isotope from a precursor isotope according to claim 3, further comprising:

purging the collection surface with an inert gas before introducing the charge into the generator system; and

purging the collection surface with an inert gas after collecting the secondary compound on the collection surface and trapping the volume of the precursor compound, but before eluting the collection surface.

6. A method for generating a secondary isotope from a precursor isotope according to claim 5, further comprising:

purging the collection surface with an inert gas after the step of eluating the collection surface.

7. A method for generating a secondary isotope from a precursor isotope according to claim 3, wherein:

trapping a volume of the precursor compound in the cold trap includes;

exposing external surfaces of the cold trap to a cryogenic fluid while passing the charge through the cold trap for a period sufficient to convert substantially all of the precursor compound present in the generator system to a liquid or a solid state.

8. A method for generating a secondary isotope from a precursor isotope according to claim 7, wherein:

substantially all of the oxygen scavenger present in the generator system is converted to a liquid or a solid within the cold trap.

9. A method for generating a secondary isotope from a precursor isotope according to claim 8, wherein:

the cryogenic fluid is liquid nitrogen.

10. A method for generating a secondary isotope from a precursor isotope according to claim 6, further comprising:

after purging the collection surface with an inert gas,

modifying the operating conditions of the cold trap to vaporize the trapped precursor compound from the cold trap and thereby recharge the generator system.

11. A method for generating  $^{68}\text{Ga}$  from a  $^{68}\text{Ge}$  precursor compound:

introducing a charge into a generator system, the charge including a volume of  $^{68}\text{Ge}$  labeled  $\text{GeH}_4$  as the precursor compound;

maintaining the charge within the generator system for a period sufficient for a quantity of the  $^{68}\text{Ge}$  labeled  $\text{GeH}_4$  to decay and produce a target quantity of a secondary compound that includes  $^{68}\text{Ga}$ ;

collecting the secondary compound on a collection surface within the generator system;

trapping a volume of the  $^{68}\text{Ge}$  labeled  $\text{GeH}_4$  in a cold trap arranged within the generator system, the cold trap being remote and separable from the collection surface;

eluting the collection surface with an eluant solution to remove a major portion of the secondary compound from the collection surface and form an eluate including  $^{68}\text{Ga}$ ;

removing the eluate from the generator system.

12. A method for generating  $^{68}\text{Ga}$  from a  $^{68}\text{Ge}$  precursor compound according to claim 11:

the charge further includes a volume of silane as an oxygen scavenger.

13. A method for generating  $^{68}\text{Ga}$  from a  $^{68}\text{Ge}$  precursor compound according to claim 12, wherein:

the charge further includes a volume of a diluent gas including one gas selected from a group consisting of hydrogen, helium, nitrogen, neon, argon, krypton and xenon.

14. A method for generating  $^{68}\text{Ga}$  from a  $^{68}\text{Ge}$  precursor compound according to claim 13, wherein:

the eluant solution is an aqueous solution of hydrochloric acid; and

the eluate includes substantially all of the  $^{68}\text{Ga}$  that was present in the collector vessel prior to the step of eluting and exhibits a  $^{68}\text{Ge}$  breakthrough of less than 0.001%.

15. A method for generating  $^{68}\text{Ga}$  from a  $^{68}\text{Ge}$  precursor compound according to claim 13, further comprising:

purging the collection surface with an inert gas before introducing the charge into the generator system; and

purging the collection surface with an inert gas after collecting the secondary compound on the collection surface and trapping the volume of the  $^{68}\text{Ge}$  labeled  $\text{GeH}_4$ , but before eluating the collection surface.

16. A method for generating  $^{68}\text{Ga}$  from a  $^{68}\text{Ge}$  precursor compound according to claim 15, further comprising:

purging the collection surface with an inert gas after the step of eluating the collection surface.

17. A method for generating  $^{68}\text{Ga}$  from a  $^{68}\text{Ge}$  precursor compound according to claim 13, wherein:

trapping the volume of the  $^{68}\text{Ge}$  labeled  $\text{GeH}_4$  in the cold trap includes;

exposing external surfaces of the cold trap to a cryogenic fluid while passing the charge through the cold trap for a period sufficient to convert substantially all of the  $^{68}\text{Ge}$  labeled  $\text{GeH}_4$  present in the generator system to a liquid or a solid state.

18. A method for generating  $^{68}\text{Ga}$  from a  $^{68}\text{Ge}$  precursor compound according to claim 17, wherein:

substantially all of the silane scavenger present in the generator system is trapped in the cold trap with the volume of the  $^{68}\text{Ge}$  labeled  $\text{GeH}_4$ .

19. A method for generating  $^{68}\text{Ga}$  from a  $^{68}\text{Ge}$  precursor compound according to claim 18, wherein:

the cryogenic fluid is liquid nitrogen.

20. A method for generating  $^{68}\text{Ga}$  from a  $^{68}\text{Ge}$  precursor compound according to claim 16, further comprising:

after purging the collection surface with an inert gas,

modifying the operating conditions of the cold trap to vaporize the trapped  $^{68}\text{Ge}$  labeled  $\text{GeH}_4$  from the cold trap and thereby recharge the generator system.

21. An apparatus for generating a secondary compound including an daughter isotope resulting from the decay of a parent isotope included in a charge of a precursor compound comprising:

a generator system for receiving the charge of the precursor compound including a collector vessel, the collector vessel including a collection surface for the collection of the secondary compound, a cold trap, the cold trap including an external surface arranged and configured to be selectively exposed to a cryogenic liquid, a pump, lines connecting the collector vessel, the cold trap and pump, and valves for controlling the flow of fluid through the generator system; and

a precursor compound source operatively connected to the generator system;

a purge gas source operatively connected to the generator system;

an oxygen scavenger compound source operatively connected to the generator system;

an eluant source operatively connected to the generator system; and

an eluate outlet operatively connected to the generator system.

22. An apparatus for generating a secondary compound including an daughter isotope according to claim 21, wherein:

the collector vessel may be selectively operated as a second cold trap and including an external surface arranged and configured to be selectively exposed to a cryogenic liquid; and

the cold trap may be selectively operated as a second collector vessel, the cold trap including a collection surface for the collection of the secondary compound.

23. An apparatus for generating a secondary compound including an daughter isotope according to claim 22, further comprising:

a recovery cold trap operatively connected to both the collector vessel and the cold trap.

24. An apparatus for generating a secondary compound including an daughter isotope according to claim 21, wherein:

the cold trap encloses a volume sufficient to contain substantially the entire charge of the precursor compound when said precursor compound is in a liquid or a solid state.

25. An apparatus for generating a secondary compound including an daughter isotope according to claim 24, wherein:

the cold trap encloses a volume sufficient to contain both substantially the entire charge of the precursor compound when said precursor compound is in a liquid or a solid state and substantially all of the oxygen scavenger compound present in the generator system when the oxygen scavenger compound is in a liquid or a solid state.